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**Associations of moderate to vigorous physical activity and sedentary behavior with depressive and anxiety symptoms in self-isolating people during the COVID-19 pandemic:
A cross-sectional survey in Brazil**

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Abstract

This is a cross-sectional study evaluating the associations of self-reported moderate to vigorous physical activity, sedentary behavior with depressive, anxiety, and co-occurring depressive and anxiety symptoms (D&A) in self-isolating Brazilians during the COVID-19 pandemic. Depressive and anxiety symptoms were collected using the Beck Depression and Anxiety Inventories (BDI and BAI). Among the 937 participants (females=72.3%), those performing ≥ 30 min/day of moderate to vigorous or ≥ 15 min/day of vigorous physical activity had lower odds of prevalent depressive, anxiety, and co-occurring D&A symptoms. Those spending ≥ 10 h/day sedentary were more likely to have depressive symptoms.

Key Words: COVID-19, Depression, Physical Activity.

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic, is a global public health emergency. To slow the spread of the virus, federal governments recommended the adoption of social distancing measures, including self-isolation (World Health Organization, 2020). While self-isolation reduces the infection rate (Bedford et al., 2020), those measures, together with the “pandemic fear” (Ornell et al., 2020; Silva et al., 2020) are linked to a negative burden on mental health, possibly increasing depressive and anxiety symptoms (Brooks et al., 2020; Wang et al., 2020). Therefore, strategies to mitigate this mental health burden are necessary (Holmes et al., 2020).

Physical activity is associated with a lower prevalence of and incidence of depression and anxiety (Schuch et al., 2019; Schuch et al., 2018; Stubbs et al., 2016; Teychenne et al., 2020). On the other hand, sedentary behavior (SB) is associated with depressive (Hallgren et al., 2020; Zhai et al., 2015) and anxiety symptoms (Teychenne et al., 2015). However, it is seen that physical activity levels decreased (Ammar et al., 2020; Lesser and Nienhuis, 2020; Meyer et al., 2020; Rogers et al., 2020; Smith et al., 2020; Stanton et al., 2020) and time spent in SB increased (Meyer et al., 2020; Qin et al., 2020; Rogers et al., 2020; Stanton et al., 2020) during in self-isolating people.

Given the influence of the COVID-19 crisis on lifestyle behaviors, depressive, and anxiety symptoms, and the associations between depressive and anxiety symptoms, it is essential to understand the relationship between MVPA and SB with depressive/anxiety symptoms in the context of COVID-19 in Brazil. The present study aimed to explore the associations between MVPA, VPA, MPA, and SB with depressive, anxiety, and comorbid depression and anxiety (D&A) symptoms in self-isolating Brazilians.

2. Methods

This is a cross-sectional study collected via an online survey. The study was approved by the Federal University of Santa Maria Research Ethics Committee and by the National Commission of Ethics in Research [CONEP] (30244620.1.0000.5346).

2.1 Recruitment and inclusion criteria

Participants were recruited through social media (Facebook, Instagram, and Twitter) and by distributing an invitation to participate through existing researcher networks. Brazilians adults (≥ 18 years), currently residing in Brazil and in self-isolation due to the COVID-19 pandemic, were eligible to participate. By self-isolation, we mean those that decided to stay-at-home and only left for essential activities such as food shopping, visit the pharmacist or other health professionals.

2.2 Variables

2.2.1. Depressive symptoms

Depressive symptoms were assessed using the Beck Depression Inventory (BDI). The BDI is composed of 21 items with a score range from 0 to 63. For the study, depression was dichotomized into no depressive symptoms (0-9) or prevalent depressive symptoms (10-63) (Beck et al., 1961).

2.2.2 Anxiety symptoms

Anxiety symptoms were assessed using the Beck Anxiety Inventory (BAI). The BAI is composed of 21 items with a score range from 0 to 63. For the study purpose, anxiety was

dichotomized into no anxiety symptoms (0-7) or prevalent anxiety symptoms (8-63) (Beck et al., 1988).

2.2.3 Co-occurring D&A symptoms

Those with prevalent depression and anxiety symptoms ($BDI > 9 + BAI > 7$) were classified as having co-occurring D&A symptoms. Co-occurring D&A symptoms was treated as a dichotomous variable.

2.2.4 Moderate to Vigorous Physical Activity (MVPA)

Time spent in MVPA was assessed by two questions, as used in a previous study (Smith et al., 2020) : 1) “How much time on an average day have you spent in vigorous physical activity since self-isolating?”; and 2) “How much time on an average day have you spent in moderate physical activity since self-isolating?”. For the logistic models, MVPA and MPA were dichotomized into 1= ≤ 30 minutes per day, or 2= ≥ 30 minutes/day, and VPA was dichotomized into 1= ≤ 15 minutes/day, or 2= ≥ 15 minutes of VPA/day. These cutoffs are in line with the public health recommendations of 150 minutes of MVPA, or 75 minutes of VPA per week (World Health Organization, 2010).

2.2.5 Sedentary behavior (SB)

Time spent sitting, henceforth defined as SB, was assessed using the question: “Since self-isolating, how much time have you spent sitting daily?”. SB was treated as a dichotomous variable for logistic models (1= ≤ 10 hours spent sitting/day; 2= ≥ 10 hours spent sitting/day). The cutoff is based on a previous study (Gibson et al., 2017) and the median of our study sample (equal to 10 hours).

2.2.6 Covariates

Demographic data were collected, including sex, age, ethnicity, marital status, employment, and household income, and Brazilian state they lived in. Participants were asked whether they are in self-isolation and to report the number of days in self-isolation. Current smoking and alcohol consumption were evaluated. Self-reported previous diagnosis of chronic physical conditions and previous diagnosis of psychiatric conditions were also evaluated with a list with a series of conditions.

2.3 Statistical analyses

Descriptive data are shown using mean (standard deviation), or median and interquartile range (IQR) for continuous variables. Categorical variables are shown as the total number of cases (%). The associations between MVPA, VPA, MPA, or SB with the prevalence of symptoms of mental health outcomes (depressive, anxiety, or D&A) were tested with logistic (using dichotomous variables) and linear (using continuous variables) regressions. First, the models were tested without adjustments (crude). Second, the models were adjusted for age, sex, ethnicity, marital status, employment, family income (adjusted 1). Third, the models were adjusted for age, sex, ethnicity, marital status, family income, days in self-isolation, current smoking, current alcohol consumption, lifetime diagnosis of chronic diseases, lifetime diagnosis of psychiatric disorders, time spent sitting (for MVPA, VPA and MPA models) or time spent in MVPA (for SB models) (adjusted 2). Regressions models were entered by blocks following the order: block 1 (crude), block 2 (adjusted 1), and block 3 (adjusted 2). Results from the logistic and linear regression models are presented as odds ratios (ORs) and beta coefficients together with their 95% confidence intervals (CIs), respectively. We adopted a statistical significance level at $p < 0.05$. The statistical analysis was performed with SPSS version 22.0 (IBM Corporation).

3. Results

A total of 937 adults were included in the study. The sample was predominantly composed of women (72.3%), and young adults aged 18-35 (52.6%). The full details of the overall sample, and stratified by the time spent in MVPA and SB, are detailed in supplementary table 1.

In the most adjusted models (adjusted 2), those reporting ≥ 30 minutes in MVPA/day had a decreased odds of prevalent depressive (OR=0.71, 95%CI=0.53-0.96), anxiety (OR=0.72, 95%CI=0.54-0.96), and co-occurring D&A (OR=0.71, 95%CI=0.52-0.96) symptoms, and those spending ≥ 15 minutes in VPA/day had with lower odds of presenting depressive (OR=0.60, 95%CI=0.43-0.82), anxiety (OR=0.70, 95%CI=0.51-0.96), and co-occurring D&A (OR=0.59, 95%CI=0.41-0.83) symptoms. Spending ≥ 30 minutes MPA/day was associated with a lower prevalence of co-occurring D&A symptoms (OR=0.72, 95%CI=0.53-0.98). Those spending ≥ 10 hours in SB/day were more likely to present depressive symptoms (OR=1.39, 95%CI=1.02-1.90). The results of the logistic regression models are presented in table 1.

Linear regression models adjusting for relevant covariates (adjusted 2), testing the dose-response association, found that every 10 minutes spent in VPA is associated with 0.18 (95%CI=0.04-0.33) points lower on the BDI, and 0.21 (95%CI=0.03-0.40) points lower on the BAI scales, respectively. Also, each hour spent in SB is associated with 0.22 points higher on the BDI (95%CI=0.10-0.33) and 0.16 points higher at the BAI (95%CI=0.02-0.31). The linear models can be seen in supplementary table 2.

4. Discussion

In the present study, participants reporting ≥ 30 minutes in MVPA/day were approximately 30% less likely to present depressive, anxiety, and D&A symptoms. Those

reporting ≥ 15 minutes of VPA/day were approximately 40% less likely to present prevalent depressive and D&A symptoms, and 30% less likely to present prevalent anxiety symptoms. Those spending ≥ 10 hours/day in SB were 39% more likely to present prevalent depressive symptoms.

Our findings are consistent with previous studies during the pandemic, suggesting that higher MVPA levels are associated with reduced depressive, anxiety and co-occurring D&A symptoms (Jacob et al., 2020; Meyer et al., 2020; Qin et al., 2020; Stanton et al., 2020). Interestingly, no associations were seen between MPA and depressive or anxiety symptoms. A potential explanation is that, during the pandemic, time spent in MPA might be heavily influenced by time spent in household activities that fall within the moderate-intensity range (Ainsworth et al., 2011), while VPA is more likely to reflect the leisure-time physical activity. It is well known that leisure-time physical activity is more closely associated with positive mental health outcomes than household activities (Teychenne et al., 2020).

Interestingly, those spending over 10 hours in SB/day were more likely to present prevalent depressive, but not anxiety or co-occurring D&A symptoms (Hallgren et al., 2018; Zhai et al., 2015). It is possible that periods longer than 10 hours/day of SB are needed to significantly increase anxiety symptoms (Hallgren et al., 2020).

The present study has some limitations. First, the cross-sectional design does not allow to draw any directionality in the relationship. Second, the sample was mostly composed of females and young adults recruited by social media (Facebook, Instagram, Twitter), living in three states (about 83% are from Rio Grande do Sul, Rio de Janeiro, or Ceará). Third, we could not rule out a sampling bias as those who are experiencing more depressive and anxiety symptoms might be more interested in participating in the study (self-selection bias). Fourth, all data was self-reported that might suffer from recall bias and social desirability.

5. Conclusion

People reporting over 30 minutes of MVPA/day or over 15 minutes of VPA/day are less likely to present depressive, anxiety, and D&A symptoms. However, those reporting higher levels of SB are more likely to present prevalent depressive symptoms.

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Authors contributions

Study conception and design: Felipe Schuch, Lee Smith, Mark Tully. Acquisition of data: Felipe Schuch, Rugero Bulzing. Analysis and interpretation of data: Felipe Schuch, Davy Vancampfort, Jeroen Deenik, Brendon Stubbs, Peter Willeit. Drafting of manuscript: Felipe Schuch. Critical revision: All authors.

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Table 1. Cross-sectional logistic associations of prevalent mental health outcomes with MVPA, VPA, MPA, and SB during COVID-19 pandemic in 2020 in Brazil

	Crude				Adj. 1				Adj. 2			
	OR	95% CI		p	OR	95% CI		p	OR	95% CI		p
MVPA												
Depression	0.673	0.517	0.877	0.003	0.686	0.520	0.906	0.008	0.718	0.537	0.960	0.025
Anxiety	0.679	0.521	0.885	0.004	0.697	0.531	0.914	0.009	0.722	0.543	0.962	0.026
Depression and anxiety	0.657	0.496	0.870	0.003	0.678	0.507	0.907	0.009	0.712	0.524	0.969	0.031
VPA												
Depression	0.622	0.465	0.832	0.001	0.606	0.447	0.822	0.001	0.601	0.437	0.826	0.002
Anxiety	0.698	0.523	0.932	0.015	0.693	0.515	0.932	0.015	0.705	0.516	0.962	0.027
Depression and anxiety	0.608	0.443	0.834	0.002	0.581	0.418	0.807	0.001	0.591	0.418	0.835	0.003
MPA												
Depression	0.736	0.565	0.958	0.023	0.724	0.549	0.956	0.023	0.765	0.572	1.022	0.070
Anxiety	0.729	0.559	0.949	0.019	0.756	0.576	0.992	0.043	0.753	0.566	1.003	0.052
Depression and anxiety	0.689	0.520	0.914	0.010	0.712	0.531	0.954	0.023	0.726	0.533	0.989	0.042
SB												
Depression	1.613	1.221	2.131	<0.001	1.497	1.113	2.012	0.008	1.396	1.025	1.901	0.034
Anxiety	1.382	1.046	1.825	0.032	1.266	0.948	1.692	0.110	1.167	0.860	1.583	0.321
Depression and anxiety	1.639	1.225	2.192	0.001	1.482	1.092	2.013	0.012	1.340	0.971	1.185	0.075

Abbreviations: CI=confidence interval; MPA=moderate physical activity; MVPA=Moderate to vigorous physical activity; OR=odds ratio; SB=Sedentary behavior, VPA=vigorous physical activity.

MVPA: odds of those who perform ≥ 30 minutes of MVPA/day compared to those that perform less than <30 minutes of MVPA (reference) of having prevalent depressive symptoms (BDI >9), anxiety symptoms (BAI >7), or co-occurring depressive and anxiety symptoms (BDI >9 & BAI >7).

MPA: odds of those who perform ≥ 30 minutes of MPA/day compared to those that perform less than <30 minutes of MPA (reference) of having prevalent depressive symptoms (BDI >9), anxiety symptoms (BAI >7), or co-occurring depressive and anxiety symptoms (BDI >9 & BAI >7).

VPA: odds of those who perform ≥ 15 minutes of VPA/day compared to those that perform less than <15 minutes of VPA (reference) of having prevalent depressive symptoms (BDI >9), anxiety symptoms (BAI >7), or co-occurring depressive and anxiety symptoms (BDI >9 & BAI >7).

SB: odds of those who spend ≥ 10 hours sitting per day compared to those spending <10 hours (reference) of having prevalent depressive symptoms (BDI >9), anxiety symptoms (BAI >7), or co-occurring depressive and anxiety symptoms (BDI >9 & BAI >7).

The models presented are: crude, no adjustments; Adjusted 1 (Adj. 1), adjusted for age, sex, ethnicity, marital status, employment, family income; and Adjusted 2 (Adj. 2), adjusted for age, sex, ethnicity, marital status, employment, family income, days in self-isolation, current smoking, current alcohol consumption, self-reported previous diagnosis of chronic diseases, self-reported previous diagnosis of psychiatric disorders, SB (continuous, for physical activity models) and MVPA (continuous, for SB models).

Supplementary table 1. Sample characteristics: overall and stratified by MVPA and SB levels.

Category		Overall N=937* (%)	Time spent in MVPA per day		Time spent in SB per day	
			<30 minutes N=437 (46.6%)	≥30 minutes N=500 (53.4%)	<10 hours N=623 (66.7%)	≥10 hours N=311 (33.3%)
Sex	Male	258 (27.7%)	124 (48.1%)	134 (51.9%)	160 (62.3%)	97 (37.3%)
	Female	674 (72.3%)	311 (46.1%)	363 (53.9%)	459 (68.3%)	213 (31.7%)
Age	18-24 years	135 (14.4%)	64 (57.4%)	71 (52.6%)	66 (49.3%)	68 (50.7%)
	25-34 years	358 (38.2%)	180 (50.3%)	178 (49.7%)	223 (62.5%)	134 (37.5%)
	35-44 years	323 (24.8%)	114 (49.1%)	118 (50.9%)	172 (74.1%)	60 (25.9%)
	45-54 years	114 (12.2%)	45 (39.5%)	69 (60.5%)	89 (78.1%)	25 (21.9%)
	55-64 years	81 (8.6%)	31 (38.3%)	50 (61.7%)	58 (71.6%)	23 (28.4%)
	≥65 years	17 (1.8%)	3 (17.7%)	14 (82.3%)	15 (93.7%)	1 (6.3%)
Ethnicity	Asian	4 (0.4%)	0 (0%)	4 (100%)	4 (100%)	0 (0%)
	Black	28 (3.0%)	13 (46.4%)	15 (53.6%)	17 (63.0%)	10 (37.0%)
	Mixed	174 (18.6%)	100 (57.5%)	74 (42.5%)	118 (68.2%)	55 (31.8%)
	Caucasian	710 (76.0%)	323 (44.1%)	397 (55.9%)	468 (66.0%)	241 (34.0%)
	Others	18 (1.9%)	10 (55.6%)	8 (44.4%)	13 (72.2%)	5 (27.8%)
Marital Status	Married	391 (42.2%)	192 (49.1%)	199 (50.9%)	283 (72.4%)	108 (27.6%)
	Widowed	4 (0.4%)	2 (50.0%)	2 (50.0%)	3 (75.0%)	1 (25.0%)
	Divorced	68 (7.3%)	27 (39.7%)	41 (60.3%)	50 (74.6%)	17 (25.4%)
Employment	Single	464 (50.1%)	212 (49.0%)	252 (54.3%)	279 (60.4%)	183 (39.6%)
	Employed	469 (50.1%)	222 (47.3%)	247 (52.7%)	316 (67.5%)	152 (35.5%)
	Unemployed	49 (5.2%)	24 (49.1%)	25 (51.0%)	36 (73.4%)	13 (26.6%)
	Student	246 (26.3%)	124 (50.4%)	122 (49.6%)	144 (58.8%)	101 (41.2%)
	Military	20 (2.1%)	12 (60.0%)	8 (40%)	14 (70.0%)	6 (30.0%)
	Self-employed	124 (13.2%)	47 (37.9%)	77 (62.1%)	316 (67.5%)	152 (32.5%)
	Retired	28 (3.0%)	8 (28.6%)	20 (71.4%)	23 (85.1%)	4 (14.9%)
Monthly household income	<R\$1254 (very low income)	35 (3.7%)	15 (42.9%)	20 (57.1%)	22 (62.9%)	13 (37.1%)
	R\$1255-R\$2004 (low income)	97 (10.4%)	50 (51.5%)	47 (48.5%)	57 (58.8%)	40 (41.2%)
	R\$2005-R\$8640 (middle income)	390 (41.7%)	182 (46.7%)	208 (53.3%)	255 (65.6%)	134 (34.4%)
	R\$8641-R\$11261 (high income)	142 (15.2%)	74 (52.1%)	68 (47.9%)	95 (66.9%)	47 (33.1%)
	>R\$11262 (very high income)	272 (29.1%)	116 (52.6%)	156 (57.4%)	193 (71.5%)	77 (28.5%)
Current smoking	No	889 (94.9%)	411 (46.2%)	478 (53.8%)	590 (66.6%)	296 (33.4%)
	Yes	48 (5.1%)	26 (54.2%)	22 (45.8%)	33 (68.8%)	15 (31.3%)
Current alcohol consumption	No	291 (31.2%)	134 (46.0%)	157 (54.0%)	203 (69.8%)	99 (30.2%)
	Yes	643 (68.8%)	300 (46.7%)	343 (53.3%)	419 (65.3%)	223 (34.7%)
Day in self-isolation	Median (IQR)	28.00 (8.00)	28.00 (8.00)	28.00 (7.00)	28.00 (8.00)	27.00 (8.00)
Time spent in MVPA (in minutes per day)	Median (IQR)	30.00 (60.00)	0.00 (0.00)	60.00 (80.00)	30.00 (80.00)	20.00 (60.00)
Time spent in VPA (in minutes per day)	Median (IQR)	0.00 (30.00)	0.00 (0.00)	20.00 (40.00)	0.00 (30.00)	0.00 (15.00)
Time spent in MPA (in minutes per day)	Median (IQR)	20.00 (60.00)	0.00 (0.00)	60.00 (30.00)	30.00 (60.00)	10.00 (30.00)
Time spent in SB (in hours per day)	Median (IQR)	10.00 (5.00)	9.00 (5.00)	10.00 (4.00)	8.00 (4.00)	12.00 (3.00)

Self-reported lifetime diagnoses of physical conditions	No	57 (6.1%)	36 (63.2%)	21 (36.8%)	36 (63.2%)	21 (36.8%)
	Yes	877 (93.9%)	479 (54.4%)	401 (45.6%)	587 (66.9%)	290 (33.1%)
Self-reported lifetime diagnoses of psychiatric conditions	No	553 (59.0%)	244 (44.1%)	309 (55.9%)	383 (69.5%)	168 (30.5%)
	Yes	383 (41.0%)	193 (50.3%)	191 (49.7%)	240 (62.7%)	143 (37.3%)
BAI	Median (IQR)	6.00 (11.00)	7.00 (11.00)	5.00 (9.00)	5.00 (10.00)	7.00 (12.00)
BDI	Median (IQR)	9.00 (10.00)	9.00 (10.00)	8.00 (8.00)	8.00 (8.00)	10.00 (12.00)

Abbreviations: BAI=Beck Anxiety Inventory; BDI=Beck Depression Inventory; IQR=Interquartile range; MPA=moderate physical activity; MVPA=Moderate to vigorous physical activity; SB=sedentary behavior; VPA=vigorous physical activity. * Total sample with available data. Number of cases can be different for each variable due to missing cases (minimum=927)

Supplementary table 2. Cross-sectional linear associations of mental health outcomes with MVPA, VPA, MPA, and SB during COVID-19 pandemic in 2020 in Brazil

	Crude				Adj.				Adj. 2			
	B	95% CI		p	B	95% CI		p	B	95% CI		p
MVPA												
BDI scores	-0.099	-0.165	-0.032	0.004	-0.071	-0.132	-0.004	0.036	-0.034	-0.096	0.028	0.281
BAI scores	-0.115	-0.196	-0.034	0.006	-0.082	-0.163	-0.004	0.038	-0.054	-0.132	0.023	0.166
VPA												
BDI scores	-0.263	-0.424	-0.102	0.001	-0.233	-0.381	-0.082	0.002	-0.188	-0.335	-0.041	0.012
BAI scores	-0.292	-0.488	-0.095	0.004	-0.251	-0.442	-0.062	0.009	-0.217	-0.400	-0.034	0.020
MPA												
BDI scores	-0.104	-0.197	-0.011	0.029	-0.370	-0.140	0.040	0.244	-0.001	-0.088	0.085	0.975
BAI scores	-0.126	-0.024	-0.001	0.029	-0.450	-0.190	0.030	0.167	-0.031	-0.139	0.077	0.570
SB												
BDI scores	0.362	0.261	0.504	<0.001	0.269	0.151	0.387	<0.001	0.221	0.104	0.338	<0.001
BAI scores	0.325	0.178	0.471	<0.001	0.236	0.089	0.384	0.002	0.167	0.021	0.313	0.025

Abbreviations: B=Beta coefficient; BAI=Beck Anxiety Inventory; BDI=Beck Depression Inventory; CI= Confidence Interval; MPA=moderate physical activity per 10 minutes, MVPA=Moderate to vigorous physical activity per 10 minutes; SB=Sedentary Behavior per hour, VPA=vigorous physical activity per 10 minutes.

The models presented are: crude, no adjustments; Adjusted 1 (Adj. 1), adjusted for age, sex, ethnicity, marital status, employment, family income; and Adjusted 2 (Adj. 2), adjusted for age, sex, ethnicity, marital status, employment, family income, days in self-isolation, current smoking, current alcohol consumption, self-reported previous diagnosis of chronic diseases, self-reported previous diagnosis of psychiatric disorders, SB (for MVPA models) and MVPA (for SB models).